

The Waxing Optimization in Finding the Best Melting Point of Wax for Staining Cirebon Batik

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Abstract

The Batik creation process cannot be separated from batik wax making process. There are many things should have been done in the making of cheap, high quality batik wax, as well as resistant to weather in the surrounding environment.

The problems encountered in the process of waxing including air temperature conditions different at each location will make the wax fragile (cracked) and does not function properly. Generally, batik artisans are not much concerned about the standard of good quality batik wax by recognizing well a melting point of wax.

Keywords: Optimization, Waxing, Melting Point, Cirebon Batik

I. Introduction

Batik has been very famous as an important textile product made from Java Indonesia. There has been a very long historical route of batik as a traditional and cultural heritage in Indonesia [1]. Now Indonesian batik has been recognized by UNESCO in the group "The Representative List of Intangible Cultural Heritage of Humanity" and establishes batik as a Masterpiece of the Oral and Intangible Heritage of Humanity generated by the Indonesian nation [2].

Batik production is essentially decorating the surface of the fabric with wax-resist technique, hurdles color using hot wax, a legacy of the pre-modern technique which is still present as a contemporary tradition.

Design batik pattern and diversity of use describe the diversity of faces in the Java community that continuously change over time. Traces of Hinduism, Buddhism and Islam can be found in addition to ethnic diversity and customs that color it. Throughout its history, the settlers, adventurers and colonists contributed their mark on the land of Java and one of the main products namely batik arts [3].

Batik industry in Java can be found in almost all regencies / cities in West Java, Central Java, and East Java to Madura. District / city of Cirebon are part area in West Java with a number of well-known batik industry and pretty much sum craftsmen [3].

Cirebon batik motif consisting of Cirebon batik Palace and coastal motif is heavily influenced by cultural changes and developments in Cirebon. It is not out of the clash from the foreign cultural influences enter the territory of Indonesia, especially in Java, Cirebon. Influence of fusion and assimilation by the Chinese, Indian, Arabic, Persian and colonial cultures (Europe), forming a distinctive culture of Cirebon as it exists today. One important element in the development of Indonesian culture, Indonesia, especially Cirebon is geo-located at the intersection of the line of traffic between the eastern region and the western continent [4].

The characteristic of Cirebon Palace Batik has a simple motif and color. Background Color of the cloth is usually light brown or ivory colors as well as the typical elements motif itself which is known as "Babarmas". The example is on Singabarong motif, which is the inspiration from Singabarong Train Kencana (Kereta Kencana Singabarong) with gold-plated original color. The general characteristic of Cirebon Batik Palace is the bold of the main motifs such as symbol that carries a specific message, without complementary elements that distract on the concentration of the main motif. There are no traditional dense ornaments that makes the fabric surface becomes more complicated [4].

The process of Cirebon batik making, like others batik, it can not be separated from the art of making wax. There are so many things have to be done in making batik wax in order to get high quality wax. The weather will greatly affect on the condition of batik wax. According to Sewan Susanto, "The formula of batik wax will create the good quality wax as follows: Resist and not easily fragile to chemicals, caustic Soda; high on the resistency; elastic/limp, not easily crack in any weather; obtaining the ornaments or motifs with the sharp lines; the wax cannot remove easily (lorod), the wax not leave the color on the fabric; easy to set; and not sticky; and must be

able to re-used" [5]. This research aims to obtain the composition of the batik wax making which has the best quality for batik waxing especially Cirebon Batik palace. Further, the next section, will explain about the Literature Review, Methodology Research, and discussion closed with a conclusion.

II. Literature Review

This section will explain the simple process of batik making. Then, it will explain the process of making batik wax. Furthermore, it presents a brief description of raw material in making batik wax and the understanding of melting point of wax.

1. The Process of Making Batik

Batik is a fabric dying method using hot wax to create patterns and designs. This method use a resist technique; applying areas of cloth with wax (a dye-resistant substance) to prevent them from absorbing colors when the cloth is dipped into dye [6]. Boehike said, in substantiating the processes of batik claimed that batik is one of the process known as a resist dyeing, in which the surface design on cloth is applied with a semi-fluid substance (wax) that resist dye. He went further to say that when the substance is removed, resulting "negative space" or motif contrast with the dye which a statement of fact is [7].

Confirming to earlier attestation Karfkar (1973) claimed that batik is a resist-dye process, which is to say that it is one of the decorative techniques in which certain design areas are covered with wax substance which would resist dyeing [7].

There are three main batik techniques, i.e: hand-waxed (hand-drawn), hand-stamped, and the combination of the two [3]. Basically, without the process of preparation of the cloth, there are seven steps in the production process of making batik, i.e.: applying the first hot wax, applying the second wax (waxing prior to indigo steeping - "nembok"), dyeing the first colour ("medel"), removing the first wax ("ngerok"), applying the third wax ("mbironi"), dyeing the second colour ("men yoga"), and removing all of the wax from cloth ("nglorod"), as in [9], [10], [11]. Before the first step (applying the first wax), the cloth has to be specially treated in order to make sure that the wax adheres evenly to the surface and will not crack during the dyeing; as also to facilitate the penetration of the dye to those parts of the cloth left uncovered. Insufficient preparation of the cloth before dyeing would result in uneven, pallid colours. In the preparation process, the cloth is first washed to remove the original starch. Then it is soaked in vegetable oil. This process is called "ngetel" or "ngloyor". To remove excess oil, the cloth is soaked in a solution of rice-straw ash and water. Nowadays, a caustic soda solution is preferred because it works more quickly. After washing and drying, the cloth is pounded with a heavy wooden mallet. By this process called "ngemplong", the cloth is smoothed out, so that the wax flows evenly over it [9].

2. Basic Ingredients of Wax Making

The wax batik material was obtained from the candle sticks that have been processed by the manufacturers. Most of the candles are made of paraffin, but it can also made from bees wax, soya, plants as well as cow's fat (a side product of the beef fat), whereas the gel wax is made from paraffin and plastic" [12].

Quick (1977) substantiated the claim that a typical wax blend is a combination of one part Beeswax and two part Paraffin. Yes it is true that the two when melted and held at a temperature just above melting point, the hot wax can be applied to the fabric with brushes, cjanting needles, and wood block or lino- blocks. Quick (1977) also claimed that the wax can then be removed from the fabric by washing in boiling water. He went further by saying that water should not be poured down the sink since the wax as it cooled, would coat the drain pipe which the researcher acknowledge[10].

Based on the researcher's experience for more than 20 years also the references batik books from Hall of Yogyakarta Batik and Handicraft (Balai Besar Batik dan Kerajinan Yogyakarta), the material for making batik wax including the following:

- a. **Mata Kucing/Damar.** The Damar tree (*Agathis dammara/Shorea*), is the plant originally from Indonesia. This amber plant spreadly grow in the Maluku and Sulawesi. The Resin plant cultivated especially in Java to take its sap or Hars. The physical properties: The melting point : 82 – 85 ° C, resistant to alkali, so it is not easily damaged when exposed to chemicals like soda
- b. **Gondorukem/Gondo/Songka/Harpus/Hars.** This material from residue of pine gum distillation (*Casuarina equisetifolia/Pinus longaeva/Pinus mercurii*). The physical properties: Transparent color (the darker more low quality). The melting point : 70–80°C, has the character which easy to penetrate the pores of the fabric, fragile or easy broken when getting treatment folded or bent, not resistant to alkali chemicals (group soda)

- c. **Microwax.** It is similar to Paraffin which is a kind of finer quality. The color is light yellow. The characteristic is limp (flexible) resembling wax kote. Microwax derived from petroleum refining, as paraffin. The physical properties: the color is light yellow, melting point: 70 ° C, easily separated in a water bath, it is difficult to penetrate the pores of the fabric, resistant to alkaline chemicals (group soda).
- d. **Paraffin.** An open-chain hydrocarbons and saturated with an alkane compounds. This substance is generally derived from petroleum, but now it can be obtained by synthesis. The physical properties are pure white color / light yellow, melting point: 56-60 ° C, easy to dilute and quickly freezes, small adhesion, wax easily off or causing the waxes cracks.
- e. **Kote/Lilin Tawon.** Bees wax is produced from beehives empty. The color of the wax is highly variable, some are yellow / orange while the other are brownish. Bees wax is easily frozen and elastic at room temperature as well as easily broken in a state of cold temperatures. The physical properties are easily broken at cold temperatures, melting point 59 ° C, easily attached to the fabric, durable (not affected by climate), easy off with hot water [8].
- f. **Dadu/Lilin Bekas.** It is a former wax remnants *pelorodan* which have been separated by water and freeze. The physical properties rather brown color towards black (because usually mixed with elements of color remnants of *pelorodan*), melting point 45-49 ° C, dilute easy, the wax easily remove when boil it (*dilorod*). Dice wax is used to degrade and loosen the wax melting point [8].
- g. **Kendal/Lemak/Vet.** Kendal or animal fat or grease. It is white like butter. Properties are easily become diluted and the melting point is 45 °C - 49 °C. Used as a mixture of wax in a relatively small number and function for lowering the melting point of the wax. The physical properties of white butter, easy to dilute, easily dislodged when dilorod, mix a little to degrade and loosen the wax melting point

3. The Melting Point of Wax

Mora Ranguti stated "Melting point defined as temperature where the solids turn into liquids at one atmosphere pressure. In other words, the melting point is the temperature when the solid and liquid phases are both in equilibrium" [13]. The melting point of the solid is the temperature at which the substance will be transformed into a liquid. According to the free encyclopedia Wikipedia (2010) the melting point of a solid substance not change significantly with a change in pressure [14]. In order to get good quality, thus the expected boiling point is less than 50 °C. Therefore, the good range melting point of batik wax is between 45 °C - 48 °C [8].

III. Methods

The research of optimization of waxing batik employs a quantitative method through experiments method. In this experimental method included a pure experiment, by using objects or special treatment for subjects who were randomly assigned [15].

This research uses experimental rules where the raw materials were treated with certain formulations result in different types of batik wax. Batik wax product, then tested with ten standard criteria by twenty testers in order to get the data. Furthermore, the data were statistically analyzed to identify the best batik wax product.

Stages in the process of making wax experiments conducted is preparing basic ingredients of wax, then the process of making wax as many as 20 kinds of the composition of the materials that have been set and the total weight of the different scales. The next step in the 20 samples of the wax print, then do the test on a white cotton cloth that has been prepared with a size of 20 cm X 20 cm by 400 sheets. Each tester will get 20 sheets and 20 sheets of wax samples of cotton fabric to test the wax. Last, the wax in the batik test by 20 people who already have experience in the field of batik.

In this experiment, researchers using ten standard criteria in testing batik wax. Measurement techniques Likert Scale (Likert rating) used in the assessment of the standard criteria by batik artisans on five types of wax from 20 products produced. The score 5 for answer number Strongly Agree, 4 for Agree, 3 for Neutral, 2 for Disagree and number 1 to strongly disagree. Then, the entire fabric that has been given candles observed and recorded for 2 weeks later and ended with dye testing of all fabric. The next step, throughout the test result data processed using the Rasch model analysis to test the instrument and transformation into ordinal data using software Winsteps ratio of 3.73. Analysis of variance (ANOVA) was used to determine the significance of batik wax which good statistically.

OPTIMIZING THE EXPERIMENTATION OF BATIK WAX MAKING

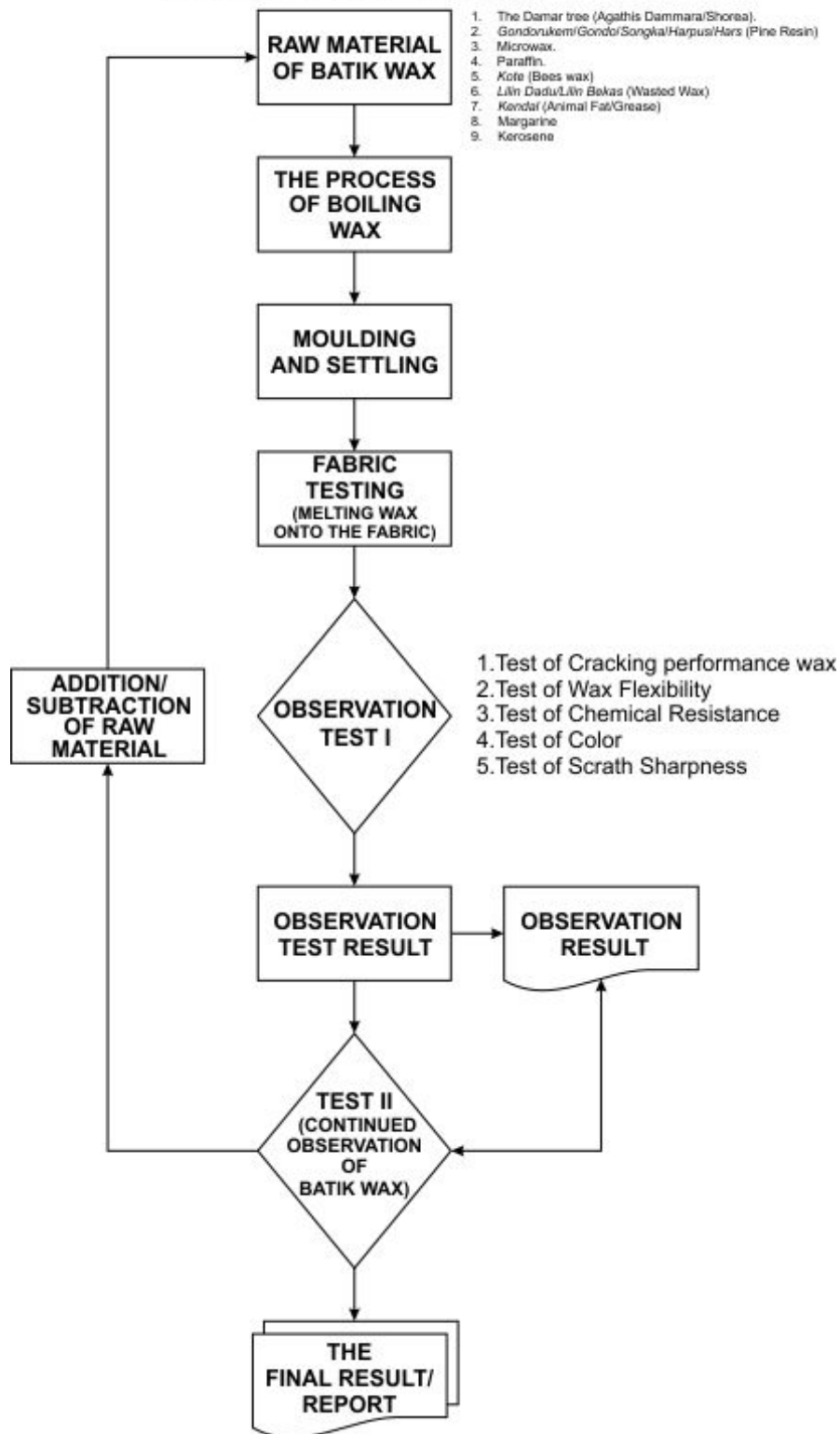


Figure 1. Framework on Experimentation of Batik Wax Making

IV. Results

Testing of 20 samples made with batik wax composition of the various mixed raw materials, it aims to obtain the accurate composition of batik wax after testing. The entire sample of wax are made with the total wax-making materials at least 10 kg, then pour it into pan wax-maker. After the wax frozen or set, then coding them based on the order of Test Code predetermined composition.

TEST 20 SAMPLES OF BATIK WAX EXPERIMENTATION												
No.	Type of Raw Materials for Making Batik Wax and Its Melting Point							Total Weight	Total TLG	Wax Melting Point	Total Cost	Test
	Damar (Shorea)	Pine Resin	Microwax	Paraffin	BeesWax	Wasted Wax	Animal Fat	Kg	Thit	MPW	wax/Kg	Code
	85	80	70	60	60	50	45					
	34.000	28.000	35.000	25.000	40.000	18.000	15.000					
	Weight Kg	Weight Kg	Weight Kg	Weight Kg	Weight Kg	Weight Kg	Weight Kg	Weight Kg	degree C	degree C	Rp.	
1	1	1	1	1	1	5	5	15	622,5	41,50	21.800	A1
2	0,5	0,5	0,5	1	2,5	2,5	2,5	10	423,75	42,38	25.600	A2
3	2	2,5	2,5	0,5	0,5	5	2	15	708,75	47,25	25.200	A3
4	2	2	2	1	0,5	5	0,5	13	624,375	48,03	25.885	A4
5	1	1	1	1	5	1	3	13	585	45,00	29.615	A5
6	1	1	1	1	1	10	2	17	708,75	41,69	21.882	A6
7	0,5	0,5	0,5	0,5	2,5	10	1	15,5	631,875	40,77	22.968	A7
8	1	2	1	1	1	10	1	17	735	43,24	22.647	A8
9	2	2	2	2	1	10	1	20	896,25	44,81	23.950	A9
10	1	1	1	1	5	10	3	22	922,5	41,93	24.864	A10
11	5	5	1	1	1	1	1	15	832,5	55,50	29.533	B1
12	5	5	0,5	0,5	0,5	0,5	0,5	12,5	725,625	58,05	30.120	B2
13	3	3	3	1	1	1	2	14	723,75	51,70	28.857	B3
14	3	3	3	1	1	1	1	13	690	53,08	29.923	B4
15	4	4	4	1	1	4	2	20	1012,5	50,63	27.750	B5
16	4	4	1	1	1	4	1	16	821,25	51,33	27.188	B6
17	5	5	0,5	0,5	0,5	5	0,5	17	894,375	52,61	26.912	B7
18	5	10	0,5	0,5	0,5	5	1	22,5	1211,25	53,83	26.889	B8
19	6	5	0,5	0,5	0,5	3	1	16,5	900	54,55	28.061	B9
20	4	20	0,5	0,5	0,5	2	2	29,5	1668,75	56,57	27.525	B10

Figure 2. Composition of batik wax experiment data

The next step of the 20 samples of batik wax with different compositions and then five samples selected for testing each one by one by 20 batik artisans who have a good batik production capabilities. Testing batik wax using canting then streaked on a white cotton cloth with a size of 30 cm X 30 cm by 400 pcs. Fabrics that have been given the wax by the examiners then hung on a thread, then observed for 2 weeks. Then, coloring process has to be done for testing the wax condition on the resistance to alkaline chemicals, as well as to observe the resulting colors on the fabric. Whether there is the onset spots or cracks in the fabric or not.

Five samples on batik wax experiment, with the code A2, A4, A8, A9 and B4 then test it for further tested (Figure 3).

Process	INPUT			Output	Conclusion
	Raw Material	Qty (Kg)	Percentage %		
Kode Uji A2	The Damar tree (Shorea)	0.5	5	Greasi, Too Mushy, Very Sticky, TMP 42.38 Celcius Degree	This Wax can not be use. It needs to add another components.
Total Weight	Pine Resin	0.5	5		
in kg	Microwax	0.5	5		
10	Paraffin	1	10		
	BeesWax	2.5	25		
	Wasted Wax	2.5	25		
	Animal Fat/Grease	2.5	25		
Process	INPUT			Output	Conclusion
	Raw Material	Qty (Kg)	Percentage %		
Kode Uji A4	The Damar tree (Shorea)	2	15.4	The Wax composition is getting better. However, it's still a little bit sticky, TMP 48.03 Celcius	This Wax can not be use. It needs to add another components.
Total Weight	Pine Resin	2	15.4		
in kg	Microwax	2	15.4		
13	Paraffin	1	7.7		
	BeesWax	0.5	3.8		
	Wasted Wax	5	38.5		
	Animal Fat/Grease	0.5	3.8		
Process	INPUT			Output	Conclusion
	Raw Material	Qty (Kg)	Percentage %		
Kode Uji A8	The Damar tree (Shorea)	1	5.9	The Wax composition is getting better. However, it's still a little bit sticky, TMP 43.24 Celcius	This Wax can not be use. It needs to add another components.
Total Weight	Pine Resin	2	11.8		
in kg	Microwax	1	5.9		
17	Paraffin	1	5.9		
	BeesWax	1	5.9		
	Wasted Wax	10	58.8		
	Animal Fat/Grease	1	5.9		
Process	INPUT			Output	Conclusion
	Raw Material	Qty (Kg)	Percentage %		
Kode Uji A9	The Damar tree (Shorea)	2	10	The Best Wax among all sample wax. The stickiness is good. TMP 44.81 Celcius Degree	The Most feasible Wax to use. The wax composition standard for making the good wax
Total Weight	Pine Resin	2	10		
in kg	Microwax	2	10		
20	Paraffin	2	10		
	BeesWax	1	5		
	Wasted Wax	10	50		
	Animal Fat/Grease	1	5		
Process	INPUT			Output	Conclusion
	Raw Material	Qty (Kg)	Percentage %		
Kode Uji A8	The Damar tree (Shorea)	3	23.1	The Wax can be used. The wax still too sticky. TMP 53.08 Celcius Degree	This Wax can not be use. The Composition of microwax needs to be subtracted.
Total Weight	Pine Resin	3	23.1		
in kg	Microwax	3	23.1		
13	Paraffin	1	7.7		
	BeesWax	1	7.7		
	Wasted Wax	1	7.7		
	Animal Fat/Grease	1	7.7		

Figure 3. 5 Samples selected Result from Experimentation

SUMMARY OF 10 MEASURED Item									
	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT		OUTFIT		
					MNSQ	ZSTD	MNSQ	ZSTD	
MEAN	387.5	100.0	.00	.12	1.00	-1.0	.83	-1.3	
S.D.	32.5	.0	.44	.01	.77	4.6	.42	2.4	
MAX.	431.0	100.0	1.06	.14	2.44	7.3	1.72	3.3	
MIN.	306.0	100.0	-.68	.11	.29	-5.4	.34	-4.1	
REAL RMSE	.14	TRUE SD	.42	SEPARATION	3.03	Item	RELIABILITY	.90	
MODEL RMSE	.12	TRUE SD	.43	SEPARATION	3.51	Item	RELIABILITY	.93	
S.E. OF Item MEAN	.15								

UMEAN=.0000 USCALE=1.0000
 Item RAW SCORE-T0-MEASURE CORRELATION = -1.00
 1000 DATA POINTS. LOG-LIKELIHOOD CHI-SQUARE: 1962.94 with 888 d.f. p=.0000
 Global Root-Mean-Square Residual (excluding extreme scores): .8288

Figure 4. Result Instrument testing by Rasch Model

In Figure 4 shows the Rasch model analysis on instruments testing of batik wax. MNSQ Infit value were 1.00 and 0.83 MNSQ Outfit (from the expectation value of 1.0); while the value for ZSTD Infit ZSTD is -1.0 and -1.3 ZSTD Outfit (from the expectation value of 0.0). Both of these indicate that the instrument is good overall, moreover it is enhanced with instrument reliability value of 0.90. Average logit instrument is 0.0 that shows the instrument can measure the opinion from five types of batik wax tested. Data logit from model of Rasch analysis is also used to transform the data into a Likert ordinal to rank ratio data for analysis of variance. ANOVA test results is shown in Table below:

	Source of Variation	Sum of Squares	d.f.	Mean Squares	F
between	37.88	4	9.469	1353.	
error	6.963	995		6.9977E-03	
total	44.84	999			

The probability of this result, assuming the null hypothesis, is less than .0001.

Results of ANOVA ($F = 1353$ with a significant 0.1 %) shows that of the five types of batik wax tested showed a statistically significant difference. The graph in Figure 4 shows that the best quality according to the batik wax is wax with a code A9 than the others. The range is shorter than the four other types of wax batik batik shows that twenty agrees in the same quality.

All data testing has been done by 20 examiners (batik artisans) who has capability in batik, then, then collected and transferred into digital data by using Excel for further analyzing the data. From the analysis of 20 data which have been summarized and processed through Rasch methods, from the test instrument; then processing the data logit into ratio; to the inferential data processing to determine which one of the wax has the best quality, see figure 4. Plots block diagram.

In conclusion, from the instrument and person (20 experts) and show the following : The response pattern are consistent with the Cronbach alpha value 0.85 means the data are valid and consistent. Average value logit for person reaches 1:25 shows the average ability of the above items; Values of validity and reliability reached 0.84. It means that the reliability from person is good; In terms of inferential statistical tests also shows a significant difference from the five types of wax are tested , even graphs blocks plot-2 clearly show which are the most qualified.

20 types of sample testing, then selected 5 samples can be considered to be representative of the 20 samples wax batik . See Test Code - A2 , A4 Test Code , Test Code A8 , A9 and Test Code Test code B4 ; The graph of the results shows that the test code - A9 almost all the experts chose as the wax composition has a good quality wax

as follows: Resist and not easily fragile to chemicals, caustic Soda; high on the resistency; elastic/limp, not easily crack in any weather; obtaining the ornaments or motifs with the sharp lines; the wax cannot remove easily (lorod), the wax not leave the color on the fabric; easy to set; and not sticky; and must be able to re-used”.

Percentage Composition of Standard materials mixture in wax making to get a good quality wax is as Follows: Melting point (MP) of the total wax ingredients are must be greater than 42°C and must be smaller than 47°C , and the best MP is 45°C .

The composition of materials as follows :

10 % of the total weight of the Shorea sp (*Mata Kucing*)

10 % of the total weight Gondorukem (*Pine Gum*)

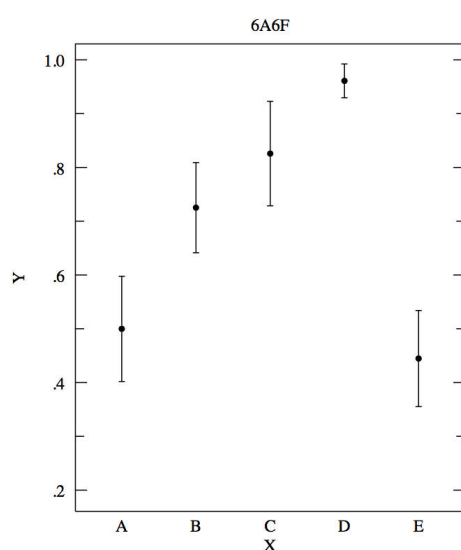
10 % of the total weight Microwax

10 % of the total weight Paraffin

5 % of the total weight of bees wax

50 % of the total weight waste wax (*Malam dadu*).

Figure 4. Block Plot



Data obtained from 20 experiment results and only 5 sample selected with the code:

- A=A2, MPW 42.24°C
- B=A4, MPW 48.03°C
- C=A8, MPW 43.24°C
- D=A9, MPW 44.81°C
- E=B4, MPW 53.08°C

*MPW is melting point of wax

The result above obtained from the sample which has closed to the MPW (Melting point of wax) from 42°C to 53°C , while the other samples is out of MPW range, thus it not shown in the diagram above because they are considered as not good wax. The samples of wax with test Code A9 got the most choices from 20 experts. It

meas the best MPW is 45°C .

V. Conclusion

1. Wax that made using kendal in large numbers will affected the wax, as follows: Conditions of wax that has been attached or affixed to the fabric, despite being resting in 2 weeks, the condition remains sticky on hands; The super stick wax, will affect on flex when stacked with other batik fabrics; When the wax is heated or diluted will cause less pleasant smell, and will make itchy throat, due to the less pleasant smells from Kendal. According to experiment result of batik wax, thus the amount of Kendal needed to make the wax is 5% out of total wax made.
2. The wax-making process which use large number of Gondorukem (pine gum) will result as follows: The wax will easily cracks, so that when it is used for batik process will affect the wax, crack easily when

folded the fabric as well as when exposed or dip to the water. However, the wax function like this will be beneficial if the result for the batik process (type of cracking) *that requires a lot of colors such as fractions or cracks* ; when put the wax off from pan a bit difficult because its too hard and sticky. Wax too liquid when heated, so that when *used or etched into the fabric using canting results are not good*. The price for the wax is too expensive as well as takes time, a relatively longer boiling time.

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